Universitas Muhammadiyah Malang, East Java, Indonesia

JPBI (Jurnal Pendidikan Biologi Indonesia)

p-ISSN 2442-3750, e-ISSN 2537-6204 // Vol. 6 No. 3 November 2020, pp. 383-388

Research Article

Application of two problem solving cycles to students' higher-order thinking skills on reproductive system material

Sekar Wiji Utami [a,1], Ari Sunandar [a,2], Arif Didik Kurniawan [a,3,*]

[a] Biology Education, Faculty of Teacher Training Education, University of Muhammadiyah Pontianak, Jl. Jendral Ahmad Yani No.111, Bangka Belitung Laut, PontianakTenggara District, Pontianak City 78124, West Borneo, Indonesia

[1] sekarfkipbio16@gmail.com, [2] arisunandar031@gmail.com, [3] arifdidikk@gmail.com *

* Corresponding author

ARTICLE INFO

Article history
Received May 2, 2020
Revised October 08, 2020
Accepted November 25, 2020
Published November 30, 2020

Keywords
High order thinking skill
Learning model
Reproductive system
Two Problem Solving Cycles

ABSTRACT

Two problem solving cycles are problem-based learning with two learning cycles that can improve students' higher order thinking skills. The knowledge of reproductive health is needed by the student, due to the student as future generation must be ready to facing the reproductive health problem in the future. This study aimed to determine the differences in learning two problem solving cycles on students' higher order thinking skills. The population of this study were students of SMA Negeri 02 Sekayam with a sample of class XI IPA 1 and XI IPA 2. Students were given 12 questions as essay test in the beginning and end of the cycles. Data were analyzed using the Mann Whitney U test. Research shows that there are significant differences in learning towards higher order thinking skills with learning two problem solving cycles (sig. 0.015 < 0.05). Hence, it could be concluded that two problem solving cycles could be applied in learning material on the reproductive system.

How to cite: Utami,S.W., Sunandar,A., & Kurniawan, A.D. (2020). Application of two problem solving cycles to students' higher order thinking skills on reproductive system material. *JPBI (Jurnal Pendidikan Biologi Indonesia), 6*(3), 383-388. doi: https://doi.org/10.22219/jpbi.v6i3.12024

INTRODUCTION

Globalization era is discovered by a competition between countries in various aspects of life including human resources (Jariyah, 2017). The quality of human resources not only will determine the progress of a country but also determine the competitiveness between nations. This condition demands an increase in the quality of human resources in the field of education. Education should be designed to be able to equip the students with challenges in the globalization era. To deal with these challenges, the students have to be able to learn independently and develop their reasoning and thinking abilities (Wahyuni et al., 2018). This is in line with the learning objectives from primary school to college, in which it is to establish intellectual people who are able to think and solve problems. In order to solve the problem on his/her own, each person is required to have the ability to think at a higher level.

Higher-order thinking skills are abilities that do not only require memory skills but also render a person to be able to carry out a series of cognitive activities such as the entry of new information, questioning the truth, and changes that may occur, managing information in various ways, points of view, and possibilities, and reviewing results as well. This series of activities are called as higher-order thinking skill (Fatimah et al., 2019).

According to Fayakun and Joko (2015), higher-order thinking skills encompass cognitive abilities in the realm of analyzing (C4), evaluating (C5), and creating (C6). Higher-order thinking skills make the students be able to differentiate ideas or notions clearly, able to solve problems, and argue well, able to hypothesize and comprehend complex matters to become clearer (Widodo & Kadarwati, 2013).

Sudewi and Tika (2014) assert that ideal learning to stimulate and practice higher-order thinking skills is by means of problem-based learning. This learning allows the students to express their ideas openly, and develop their thinking abilities. The advantages of problem-based learning are providing students with diverse learning experiences such as collaboration and interaction in groups, increasing students' understanding of what they are learning, gaining learning experiences related to the skills of applying scientific methods in problem-solving, and fostering a critical mindset (Rahayuni, 2016). Thru problem-solving, the students can transfer knowledge and understand the physical situation around them. Problem-solving skill is an individual competence to discover the solution in various problems thru logical ways (Demirel et al., 2015; Dostál, 2015). Problem-solving learning can use two cycles so that the learning is more effective (Puspitawati et al., 2018). Problems allow students' initial knowledge to be built to relate new information to an event (Sitti et al., 2013).

Two problem solving cycles is a problem-based learning in two learning cycles. The learning stages of problem-solving in each cycle consist of (1) identifying problems; (2) problem formulation; (3) designing & implementing the problem stages; (4) analyzing the results; and (5) concluding and reflecting as well. In this case, first cycle focuses on obtaining the human reproduction concept (this material is used due to the lack of student knowledge about the reproductive system). Then, it is followed by the second cycle to implement the concept of complex problems related to human reproductive system. Both of the cycles allow the students to implement their concept thru a scientific approach to solve the problems (Riantoni et al., 2017).

Learning method that usually applied by the teacher in class is lecture method. However, it should be when the learning process, the teachers need to stimulate the students' higher-order thinking skills. Previous learning methods need to be improved in order to improve the students' higher-order thinking skills by applying the appropriate model; thus, this study is important. According to Puspitawati et al. (2018), two problem solving cycles can improve the students' thinking skills and it is effective to be used in the learning. Departing from the above background, this study is carried out to discover whether there are differences in learning two problem solving cycles on the students' higher-order thinking skills or not. Problem-solving skill is very important to be possessed by the students. This skill can assist the students in dealing with rapid societal changes (Kurniati et al., 2016). Problem-solving skill is integrated in the learning activities, especially in the field of science and technology (Destalia et al., 2014). The results of this study can be used as a reference for further study of two problem solving cycles learning.

METHOD

This experimental study is carried out using non-equivalent control group design as elucidated in Table 1.

Table 1. Design of non-equivalent control group design

Class	Pretest	Treatment	Posttest
Experiment 1	O1	X1	O2
Experiment 2	O3	X2	O4

This study is conducted in SMA Negeri 02 Sekayam on the even semester of academic year of 2019/2020. Population used in this study is the whole students of 11th grade of Natural Science. The XI IPA 1 class is used as the experimental class 1 and the XI IPA 2 class is used as the experimental class 3 based on the homogeneity test of final exam results and it is stated that both of classes are homogenous; hence, sampling uses a saturation sampling technique. The experimental class 1 uses two problem solving cycles and the experimental class 2 uses problem-based learning. Numbers of students embroiled in this study are 60 students, in which the numbers can be seen in Table 2.

Table 2. The students involved in the study

Class	Gender		Total n
	Male n (%)	Female n (%)	
11th Grade of Natural Science 1 (XI IPA 1)	9(30)	21(70)	30
11th Grade of Natural Science 2 (XI IPA 2)	15(50)	15(50)	30

Learning stages of two problem solving cycles consist of identifying problems; problem formulation; designing and implementing problem-solving stages; analyzing the results; and concluding and reflecting. The

first cycle focuses on obtaining the concept of reproductive system in humans, followed by the second cycle to apply the concept of complex problem conditions related to human reproduction table as shown in Figure 1. Stages of problem-based learning are shown in Table 3.

Table 3. Operational syntax of problem-based learning

Operational syntax of problem-based learning
1. A problem is provided to the students
2. Students discuss a problem of PBL tutorial in a small group. The students clarify facts of a case or problem; then, the students define a problem
3. Students are embroiled in an independent study to finalize a problem outside the teacher's guidance
4. Students share information about the problem
5. Students provide a solution of the problem
6. Students conduct a review about what they have learned during the operation process

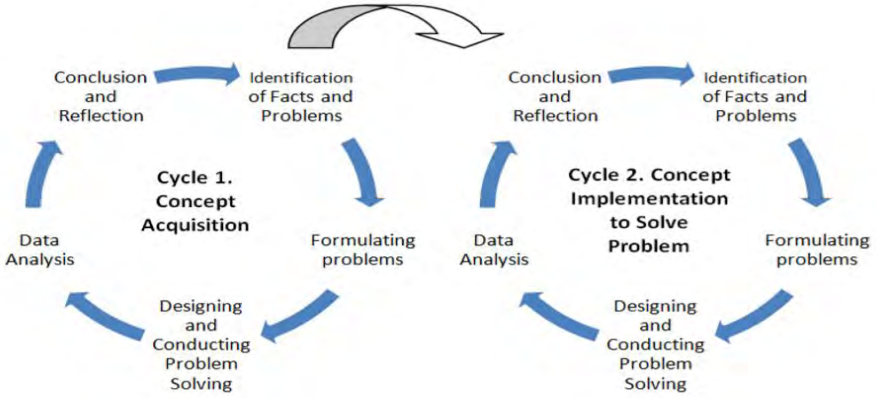

Figure 1. Learning concept of two problem-solving cycles (Puspitawati et al., 2018)

Test instrument is used as data collection tool. The test instrument is established based on the higher-order thinking skill indicators i.e. analyzing, evaluating, and creating (Alhaddad et al., 2015). The test instrument is composed of 12 essay questions. All of the items are declared valid and the test instrument is feasible to be used, the validation is carried out by two lecturers and a teacher. All of the items meet the criteria for the level of difficulty and different power parameters. After the data are obtained, data analysis is required by using SPSS 22.

RESULTS AND DISCUSSION

The data results of pretest and posttest of students for each class are used as basic analysis to identify whether there are differences in learning two problem solving cycles on the experimental class 1 and problem-based learning on the experimental class 2. The analysis results of pretest score indicate the mean score of experimental class 1 (38,23) and the experimental class 2 (35.97). Those results indicate that the initial skill of the two classes is still low, in which it is shown in the Table 4. The normality and homogeneity tests show the data that normally distributed and homogenous. Then, T-test obtains the results of sig (2-tailed) 0.458 > 0.05, in which it indicates that the pretest score of experimental class 1 and experimental class 2 do not have a significant difference on the students' initial skills. Furthermore, the posttest score was tested to determine the final ability of higher-order thinking skills in the experimental class 1 and experimental class 2, it can be seen in Table 5.

The analysis results of posttest score indicate the mean score of experimental class 1 (51.43) and experimental class 2 (44.03). The normality test of posttest obtains the results of data that are not normally distributed as shown in Table 5. Based on the results of U Mann Whitney test in Table 6, it shows that the posttest score of experimental 1 and experimental class 2 have a significant difference on the final skill of higher-order thinking of students.

Table 4. Test results of pretest score

Class	Mean	SD	Normality test	Homogeneity test	T-test
					Sig (2-tailed)
Experiment 1	38.23	11.443	0.051	0.853	0.458
Experiment 2	35.97	12.003	0.112		

Table 5. Test results of posttest score

Class	Mean	SD	Normality Test
Experimental	51.43	9.310	0.041
Control	44.03	10.987	0.114

Table 6. Mann Whitney test

	Posttest
Mann Whitney U	289.000
Wilcoxon W	754.000
Z	-2.425
Asymp Sig. (2-tailed)	.015

The difference in the students' high-order thinking skills between the experimental class 1 and the experimental class 2 is due to differences in the treatment given, where the experimental class 1 uses two problem solving cycles and the experimental class 2 uses problem-based learning. The implementation of two problem solving cycles of learning gives the same results in terms of analysis so that there are no other factors that influence the results obtained (Puspitawati et al., 2018). Higher-order thinking skill can make an individual to be able to interpret, analyze or even manipulate the information that has been obtained. Based on Fayakun and Joko (2015), higher order thinking skills encompass the cognitive ability i.e. analyzing (C4), evaluating (C5), and creating (C6). The students who have higher-order thinking skills are able to identify the main ideas, analyze the argumentation, and provide the use of known things to answer questions, so that it has fairly good analytical skills. The students are able to give assessment to the learning and solution used. The students are also able to design how to work and provide correct answers; thus, the students have fairly good creation ability (Kurniati et al., 2016). In this study, the students are given problems in the form of news clippings in each meeting cycle. According to Rofiah et al (2013), one of the ways to improve the students' higher order thinking skills is by exposing the students to a problem they have never encountered before. This can continuously train the students' higher-order thinking skills. Higher-order thinking can also be interpreted as thinking at a higher level, not just memorizing facts. Thru a learning of *two problem solving cycles,* it can improve the students' higher order thinking skills and it is effectively used in learning (Puspitawati et al., 2018).

There are two cycles in problem-solving learning that are effective to achieve the results of problem-solving learning. In the implementation of two cycles, repetition can be carried out to practice the problem-solving skill and check out the concept (Destalia et al., 2014). *Two problem solving cycles* is a learning based two cycles of meeting by using problem-based learning. The first cycle focuses in obtaining the concept of reproductive system in human, followed by the second cycle to implement the concept of complex problems related to the human's reproductive system. The two cycles allow the students to implement their concept thru a scientific approach in order to solve the problems (Lestari, 2015; Riantoni et al., 2017). The learning that uses problem-solving will improve the students' success and metacognition ability (Safitri et al., 2018; Saptasari et al., 2019). The use of *two problem solving cycles* learning will improve the higher order thinking skills of students thru a learning process of problem-based learning so that the students are easier to comprehend the learning concept especially in the reproductive system material. This learning also can improve the cognitive process including conceptual understanding, problem-solving skills, and ability to problem-solving (Khoiriyah & Husamah, 2018; Wulandari & Surjono, 2013). Two problem solving cycles for each topic can develop a critical thinking and problem-solving skill (Purcell et al., 2012). The increase in students' higher-order thinking skills makes the students more independent and can achieve better learning achievement as well. Problem solving skills are important skills in science learning (*IPA*) (Kurniati et al., 2016; Ramdiah et al., 2019). Garvey (2015) postulate that problem-solving is very important for students and it can build up a new scientific knowledge. Batubara (2017) assumes that problem-solving method simplify the students in completing daily problems since to achieve the understanding, the students must do the thinking activities by planting the concept of taking problems.

The results of this study indicate that the learning of two problem solving cycles is better that the problem-based learning in the learning outcomes of higher-order thinking skills, it can also be understood that a lot of

studies are needed in the future. Problem based learning is one of the methods that mostly used and proven to improve the ability to discuss, ask questions, and think critically (Schmidt et al., 2011; OECD 2013). Additionally, it can improve the students' thinking skill in various academic fields (Hambach et al., 2016; Li et al., 2011; Van Hayus et al., 2014). Problem-based learning is learning that has an essence in the form of presenting various authentic and meaningful problem situations to the students. The results of this study prove that two problem solving cycles have the same potential success as problem-based learning.

CONCLUSION

There is a significant difference in learning to the higher-order thinking skills by the application of two problem solving cycles learning than problem-based learning in reproductive system material, in which the value of the significant difference is 0.015.

ACKNOWLEDGEMENT

We would like to thank the Principal, Biology Teachers, and Students of 11th grade of Natural Science in SMA Negeri 02 Sekayam.

REFERENCES

Alhaddad, I., Kusumah, Y. S., Sabandar, J., & Dahlan, J. A. (2015). Enhancing students' communication skills through treffinger teaching model. *Journal on Mathematics Education*, *6*(1), 31–39. doi: https://doi.org/10.22342/jme.6.1.1856.31-39

Batubara, M. S. (2017). Hasil uji coba video pembelajaran mata kuliah kultur jaringan berbasis masalah pada dosen dan mahasiswa program studi pendidikan biologi UMTS. *Jurnal Pendidikan Biologi*, *6*(2), 44–52. doi: https://doi.org/10.24114/jpb.v6i2.6544

Demirel, M., Derman, I., & Karagedik, E. (2015). A study on the relationship between reflective thinking skills towards problem solving and attitudes towards Mathematics. *Procedia - Social and Behavioral Sciences*, *197*(March), 2086–2096. doi: https://doi.org/10.1016/j.sbspro.2015.07.326

Destalia, L., Suratno, & Aprilya, S. (2014). Peningkatan keterampilan pemecahan masalah dan hasil belajar melalui penerapan pembelajaran berbasis masalah (PBM) dengan metode eksperimen pada materi pencemaran lingkungan. *Pancaran*, *3*(4), 213–224.

Dostál, J. (2015). Theory of problem solving. *Procedia - Social and Behavioral Sciences*, *174*, 2798–2805. doi: https://doi.org/10.1016/j.sbspro.2015.01.970

Fatimah, S., Muhsetyo, G., & Rahardjo, S. (2019). Proses berpikir tingkat tinggi siswa SMP dalam menyelesaikan soal PISA dan scaffoldingnya. *Jurnal Kajian Pembelajaran Matematika*, *3*(1), 24–33. Retrievied from http://journal2.um.ac.id/index.php/jkpm/article/view/5430

Fayakun, M., & Joko, P. (2015). Efektivitas pembelajaran fisika menggunakan model kontekstual (Ctl) dengan metodepredict, observe, explain terhadap kemampuan berpikir tingkat tinggi. *Jurnal Pendidikan Fisika Indonesia*, *11*(1), 49–58. doi: https://doi.org/10.15294/jpfi.v11i1.4003

Garvey, G. P. (2015). Fostering 21st century skill through game design and development. *12th International Conference on Cognition and Exploratory Learning in Digital Age*, 385–386. Retrieved from https://files.eric.ed.gov/fulltext/ED562163.pdf

Hambach, J., Diezemann, C., Tisch, M., & Metternich, J. (2016). Assessment of students' lean competencies with the help of behavior video analysis-are good students better problem solvers? *Procedia CIRP*, *55*, 230–235. doi: https://doi.org/10.1016/j.procir.2016.08.012

Jariyah, I. A. (2017). The effect of inquiry combined science-technology-society (STS) learning to enhance critical thinking skills on science. *Jurnal Pendidikan Biologi Indonesia*, *3*(1), 1. doi: https://doi.org/10.22219/jpbi.v3i1.3888

Khoiriyah, A. J., & Husamah, H. (2018). Problem-based learning: Creative thinking skills, problem-solving skills, and learning outcome of seventh grade students. *Jurnal Pendidikan Biologi Indonesia*, *4*(2), 151–160. doi: https://doi.org/10.22219/jpbi.v4i2.5804

Kivunja, C. (2015). Teaching students to learn and to work well with 21st century skills: unpacking the career and life skills domain of the new learning paradigm. *International Journal of Higher Education*, *4*(1), 1–11. Retrieved from https://eric.ed.gov/?id=EJ1060566

Kurniati, D., Harimukti, R., & Jamil, N. A. (2016). Kemampuan berpikir tingkat tinggi siswa SMP di Kabupaten Jember dalam menyelesaikan soal berstandar Pisa. *Jurnal Penelitian dan Evaluasi Pendidikan*, *20*(2), 142. doi: https://doi.org/10.21831/pep.v20i2.8058

Lestari, S. (2015). Analisis kemampuan technological pedagogical content knowledge (TPACK) pada guru Biologi SMA dalam materi sistem saraf. *Seminar Nasional XII Pendidikan Biologi FKIP UNS 2015*, *1*(1), 123–136. Retrieved from https://jurnal.uns.ac.id/prosbi/article/view/7006

Li, Y., Yang, M. H., Klein, G., & Chen, H. G. (2011). The role of team problem solving competency in information system development projects. *International Journal of Project Management*, *29*(7), 911–922. doi: https://doi.org/10.1016/j.ijproman.2010.09.004

OECD (2013). PISA 2012 results: what students know and can do student performance in mathematics, reading and science volume I. In *CrossRef Listing of Deleted DOIs* (Vol. 1). doi: https://doi.org/10.1787/9789264201118-en

Purcell, K., Rainie, L., Heaps, A., Buchanan, J., Friedrich, L., Jacklin, A.,. Zickuhr, K. (2012). How teens do research in the digital world. *Pew Internet & American Life Project*, (February), 1–115.

Puspitawati, R. P., Yuanita, L., Rahayu, Y. S., Indana, S., & Susiyawati, E. (2018). Two problem solving cycles to achieve learning outcomes of thinking skills and plant anatomy concept mastery. *Jurnal Pendidikan IPA Indonesia*, *7*(3), 312–321. doi: https://doi.org/10.15294/jpii.v7i3.14295

Rahayuni, G. (2016). Hubungan keterampilan berpikir kritis dan literasi sains pada pembelajaran IPA terpadu dengan model PBM dan STM. *Jurnal Penelitian Dan Pembelajaran IPA*, *2*(2), 131–140. doi: https://doi.org/10.30870/jppi.v2i2.926

Ramdiah, S., Abidinsyah, A., Royani, M., & Husamah, H. (2019). Understanding, planning, and Implementation of HOTS by Senior High School biology teachers in Banjarmasin-Indonesia. *International Journal of Instruction*, *12*(1), 425–440. doi: https://doi.org/10.29333/iji.2019.12128a

Riantoni, C., Yuliati, L., Mufti, N., & Nehru, N. (2017). Problem solving approach in electrical energy and power on students as physics teacher candidates. *Jurnal Pendidikan IPA Indonesia*, *6*(1), 55–62. doi: https://doi.org/10.15294/jpii.v6i1.8293

Rofiah, E., Aminah, N., & Ekawati, E. (2013). Penyusunan instrumen tes kemampuan berpikir tingkat tinggi fisika pada siswa SMP. *Jurnal Pendidikan Fisika Universitas Sebelas Maret*, *1*(2), 120699. Retrieved from https://jurnal.fkip.uns.ac.id/index.php/pfisika/article/view/2797/1913

Safitri, D., Bachtiar, S., & Rukman, W. Y. (2018). Students ' cognitive achievement, critical thinking skills, and metacognitive. *European Journal of Education Studies*, *5*(4), 248–258. doi: 10.5281/zenodo.1482095

Saptasari, M., Sunarmi, S., Sulasmi, E. S., Wicaksono, R. S., & Sudrajat, A. K. (2019). Information literacy skill: An alternative to support biology student's learning outcomes. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, *5*(3), 451–458. doi: https://doi.org/10.22219/jpbi.v5i3.8768

Schmidt, H. G., Rotgans, J. I., & Yew, E. H. J. (2011). The process of problem-based learning: What works and why. *Medical Education*, *45*(8), 792–806. doi: https://doi.org/10.1111/j.1365-2923.2011.04035.x

Sitti, S., Sopeerak, S., & Sompong, N. (2013). Development of instructional model based on connectivism learning theory to enhance problem-solving skill in ICT for daily life of higher education students. *Procedia-Social and Behavioral Sciences*, *103*, 315–322. doi: 10.1016/j.sbspro.2013.10.3 39

Sudewi, N., & Tika, M. (2014). Studi komparasi penggunaan model pembelajaran problem based learning (Pbl) dan kooperatif tipe group investigation (Gi) terhadap hasil belajar berdasarkan taksonomi Bloom. *Jurnal Pendidikan dan Pembelajaran IPA Indonesia*, *4*(1). Retrieved from https://ejournal-pasca.undiksha.ac.id/index.php/jurnal_ipa/article/view/1112

Van Hayus, E. S., Magdalena, O., & Mulyani, S. (2014). Pengaruh pembelajaran model problem based learning dan inquiry terhadap prestasi belajar siswa ditinjau dari kreativitas verbal pada materi hukum dasar kimia kelas X SMAN 1 Boyolali tahun pelajaran 2013/2014. *Jurnal Pendidikan Kimia*, *3*(4), 162–169. Retrieved from https://jurnal.fkip.uns.ac.id/index.php/kimia/article/view/4617/3192

Wahyuni, S., Miarsyah, M., & Adisyahputra, A. (2018). Correlation between achievement motivation and reading comprehension ability through science literacy to High School students. *Indonesian Journal of Science and Education*. doi: https://doi.org/10.31002/ijose.v2i2.613

Widodo, T., & Kadarwati, S. (2013). Problem-solving-based higher order thinking to improve learning achievement Through students' character building orientation. *Cakrawala Pendidikan*, *32*(1), 161–171.

Wulandari, B., & Surjono, H. D. (2013). Pengaruh problem-based learning terhadap hasil belajar ditinjau dari motivasi belajar PLC di SMK. *Jurnal Pendidikan Vokasi*, *3*(2). doi: https://doi.org/10.21831/jpv.v3i2.1600